EVALUATION OF WATER QUALITY MANAGEMENT PROBLEMS CAUSED BY AGRICULTURAL DRAINAGE WATER ENTERING MODOC NATIONAL WILDLIFE REFUGE AND THE ASH CREEK WILDLIFE MANAGEMENT AREA

California Regional Water Quality Control Board
Central Valley Region
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I. SUMMARY

During 1987, the water supplies entering the Modoc National Wildlife Refuge and the Ash Creek Wildlife Management Area were sampled for pesticides and heavy metals conceivably associated with agricultural drainage. Purpose of the sampling was to determine if concentrations of toxic substances were present that would pose a threat to fish and wildlife.

Sampling was done in January and June corresponding to the primary periods of chemical application in the watershed areas. Only pesticides used currently or previously in the areas were analyzed.

Samples did not contain pesticides at detectable concentrations. Metal results were similar to background levels for surface waters in the Pit River system.

Board staff concludes that agricultural chemical use or other toxics do not pose a threat to fish and wildlife in the two areas. Accordingly, additional intensive monitoring does not appear to be a priority activity unless chemical usage changes in the watersheds supplying the wildlife areas.

II. INTRODUCTION

A. Objective

The objective of this investigation was to determine water quality problems or potential problems caused by agricultural drainage water entering the Modoc National Wildlife Refuge and the Ash Creek Wildlife Management Area.

B. Scope

California provides vital wetland habitat for over 60% of the Pacific flyway's total waterfowl population. Wildlife refuges and management areas within the state have relied on irrigation return flow as part of their firm water supply [1]. Because of the varied nature of irrigated agriculture surrounding many of

these sites, these return flows could contain harmful substances. Nonpoint source agricultural drainage water may contain dissolved and suspended constituents which potentially threaten beneficial uses, including fish and wildlife [2]. Trace element concentrations in irrigation drainage water evaporation ponds have resulted in toxic effects on wildlife populations in Kesterson National Wildlife Refuge. Pesticides, salts, and excess nutrients are suspected in fish kills and avian botulism problems that have occurred in canals and wildlife refuges. Bioaccumulation of certain metals and pesticides is also a serious concern for chronic effects.

The study consisted mainly of reconnaissance monitoring of water flowing into, within, and out of the refuge/wildlife areas. These areas were selected for study along with three other similar areas in the Central Valley either because of the nature of agriculture in the immediate vicinity draining into the refuge, or because the refuge contains a unique habitat that would be seriously damaged by a contaminant in the agricultural return flow [3].

Past studies indicate that turbidity/sedimentation and nutrients could be ruled out as threats to beneficial uses in the study areas [4,5,6, & 7]. Accordingly, the study focused on the unknown aspects of agricultural drainage water entering the study areas, specifically the use of pesticides upstream from the areas.

III. CHARACTERISTICS OF STUDY AREAS

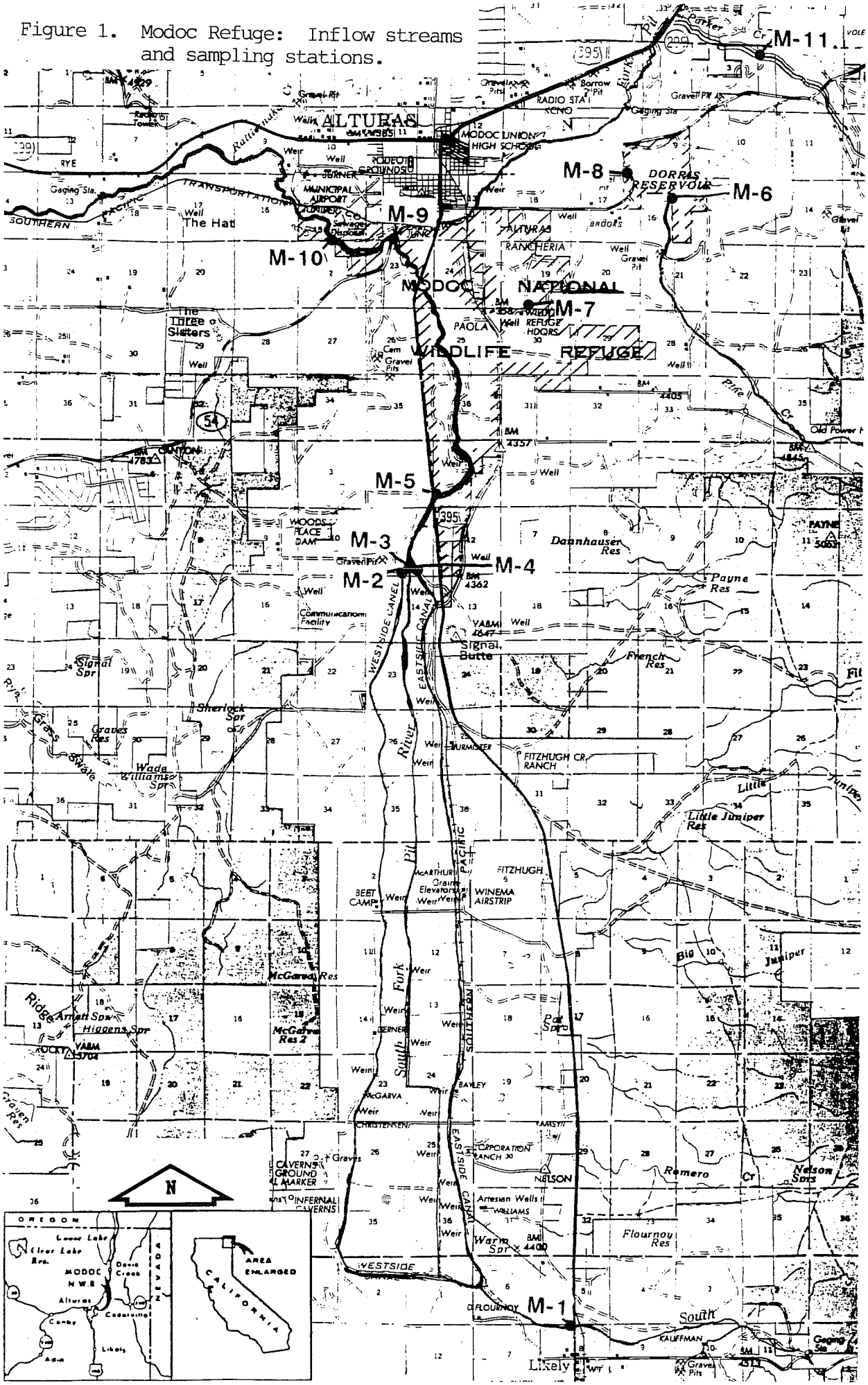
A. Modoc National Wildlife Refuge

Modoc National Wildlife Refuge was established by the Migratory Bird Conservation Commission on April 8, 1959. The 6,203-acre refuge is located in Modoc County just south of Alturas in the Pit River Valley (Figure 1). This agricultural valley lies at 4,300 feet elevation at the western base of the Warner Mountains. The Modoc Plateau is a thick accumulation of geologically young volcanic rocks [8]. The Warner Range is an uplifted mountainous part of the plateau composed of similar volcanic materials [9].

1. Water Supply

Local watersheds provide the entire refuge water supply. The South Fork Pit River, Pine Creek, Parker Creek, and Dorris Reservoir are the major sources of water. The average annual amount of water delivered to the refuge from 1976 to 1981 was 18,050 acre-feet (Bureau of Reclamation, 1986). The South Fork Pit River was the major supply with an average delivery of 9,895 acre-feet. Dorris Reservoir supplied 6,369 acre-feet, and Pine

Figure 1. Modoc Refuge: Inflow streams and sampling stations.



Creek provided an average of 1,790 acre feet over and above diversion to Dorris Reservoir. No ground water was pumped on the refuge.

Pine Creek and Parker Creek both originate in the pristine highlands of the South Warner Wilderness Area. Most of the flow of Pine Creek is diverted to storage in Dorris Reservoir via a ditch. The natural stream channel of Pine Creek flows directly into the refuge where it joins the South Fork Pit River. The Stockdill Slough is a natural drainage channel which delivers about 5000 acre-feet of snowmelt runoff to the east side of Dorris Reservoir each spring. The Parker Creek allotment is delivered to the east side of the reservoir via a ditch. Dorris Reservoir water is used on the central and eastern portions of the refuge.

Mill Creek and East Creek flow from the drainage divide in the South Warner Wilderness Area and merge in Jess Valley to form the South Fork Pit River. The South Fork flows west through Likely where the entire flow is diverted north via the natural channel and the Eastside and Westside Canals of the South Fork Irrigation District (SFID). Two warm springs are tributary from the east to the Eastside Canal immediately below the head of the canal. Fitzhugh Creek is also an important tributary from the east. Metzler Canal is fed by several perennial springs to the southwest of Likely, and is tributary to the Westside Canal. An intermittent stream flows through Crooks Canyon into the Westside Canal about 5 miles below Likely. The confluence of the canals is at the southern refuge boundary where the river continues through the refuge to join the North Fork Pit River. The irrigation district's northern boundary forms the southern boundary of the refuge. South Fork water is diverted for use in permanent wildlife habitat ponds on the west side of the refuge.

2. Land Use

Agricultural land use in the Pine Creek and Parker Creek watersheds is limited to grazing lands and minor amounts of mixed grass and alfalfa hay production. The agricultural irrigation season of the Modoc Plateau extends from May through early September.

The South Fork is commingled with agricultural drainage water. SFID diverts water from the Eastside and Westside Canals to irrigate 13,000 acres of alfalfa, mixed grass hay, and other crops in the valley (Table 1) [10]. The distribution and collection system consists of a series of weirs and diversion dams. Approximately 25 percent of the surface water used in the district is discharged back to the central channel as agricultural return flow. The Department of Water Resources (DWR) provided Watermaster Service on the South Fork from 1931 to 1982 [11].

TABLE 1. CROP PRODUCTION AND CHEMICAL USE IN MODOC COUNTY WATERSHED UPSTREAM FROM MODOC NATIONAL WILDLIFE REFUGE, 1985

Crop	Acreage	Estimate of Pesticides Used Since 1980	Season of Use
Alfalfa	6,290	2,4-D	Spring
		Eptam	Spring
		Furadan	Spring
		Simazine	Spring/Fall
		Velpar	Fall
		Sencor	Spring
		Picloram	Summer
		1080	Winter
Meadow Hay	13,375	Velpar	Spring
		Picloram	Summer
Grain Hay	1,925	2,4-D	Spring
		Picloram	Summer
		1080	Winter
Irrigated Pasture	19,500	Velpar	Spring
		Simazine	Spring/Fall
		Picloram	Summer
Wheat	155	2,4-D	Spring
		Dicamba	Spring
Barley	450	2,4-D	Spring
		Dicamba	Spring
Oats	205	2,4-D	Spring
		Dicamba	Spring
Rye	125	?	?
Wild Rice	40	Malathion	Spring

(Magnacide (Acrolein) was also used in canals in this system south of the refuge during summer months for aquatic weed control.)

Lyneta Ranches, the largest single production unit in the SFID, produces alfalfa and mixed grass hay on 4,000 acres in the valley upstream from the south refuge boundary. The Lyneta operation includes about 30 percent of the SFID, and extends almost to the town of Likely. They and other land owners have undertaken a major program of land leveling and modernizing irrigation farming practices over the last five to ten years. A wild rice trial at Lyneta Ranches in 1986 proved to be a successful venture, and acreage will likely increase in future seasons. The balance of the growers in the SFID are mixed grass and alfalfa hay producers, including cattle ranches with irrigated pasture and hay production in the area east of Likely.

3. Pesticide Use

The Modoc County Report on Environmental Assessment of Pesticide Programs indicates that 90 percent of the restricted pesticide use in the county is directed at the control of weeds and aphids (California Department of Food and Agriculture, 1978) [12]. Over 50 percent of all restricted pesticide use in the county was the herbicide 2,4-D. Irrigation district use of pesticides included 2,4-D, dicamba, paraquat, and magnicide for weed control. Carbofuran (Furadan), parathion, and 2,4-DB were reported for use on alfalfa.

4. Geology

The chemical quality of water moving into the refuge is influenced by the geology in its path. The oldest rocks in the Warner Mountains are the Cedarville Series which consists of interbedded andesitic lava flows and pyroclastic rocks. The Alturas Formation is exposed along the Pit River Valley 20 miles west and south of Alturas. These Pliocene lake deposits include diatomaceous and tuffaceous silty and sandy shale, siltstone, and sandstone. Warner basalts are prominent throughout the watershed. Springs are common throughout the region as many lava flows are open and porous, providing natural conduits for flow of underground water [8 & 13].

The surface water resources of the Alturas Basin are primarily runoff and snowmelt draining out of the Warner Mountains. This basaltic landscape is typified by surface rocks of high permeability. Therefore, the regional hydrology of the area is characterized by minimal surface flows due to the well-drained soils and geologic formations. However, the underlying Cedarville Series are much less permeable, and the rocks of the Cascade Range constitute a barrier to the westward movement of ground water. The result is a shallow water table throughout much of the Modoc Plateau. The surface water flows are not sufficient to last through the entire irrigation season. Ground water resources are relied upon to supplement surface water from

July through September. Although ground water is not pumped on the wildlife refuge, ground water is commingled with South Fork water as agricultural return flow from SFID.

5. Water Quality

The Alturas Formation is the principle water bearing formation in the basin [6]. The formation contains both confined and unconfined ground water. Ground water levels are less than 50 feet, and about 50 percent of the wells measured by DWR are less than 25 feet below the ground surface. The South Fork drainage area surrounding Likely is a known area of geothermal activity as evidenced by thermal springs and wells. The volcanic hot springs and wells of this geologic fault region discharge highly mineralized water that may degrade adjacent surface waters.

The mineral quality of the Pit River headwaters is considered to be excellent. There are no data available to show the changes in water quality as water moves into and out of SFID, but Table 2 provides a summary of surface water quality near Likely.

Table 2. Water Quality Data for the South Fork Pit River near Likely

	Constituents							
Month	Q	EC	B	Na	HCO3	DO	T	TRB
Jan	1.9	106	0.0	5.4	61	12	1.5	75
Feb	2.5	133	0.0	6.3	75	12	1.5	--
Mar	2.8	106	0.0	5.9	64	11	9.6	--
Apr	7.2	114	0.0	6.0	66	11	6.9	--
May	14.0	105	0.1	6.2	59	10	13.0	25
Jun	10.0	105	0.3	5.5	61	9.2	14.0	--
Jul	4.2	127	0.1	6.6	71	8.4	20.0	--
Aug	6.7	141	0.0	9.7	83	8.4	18.0	--
Sep	2.9	148	0.03	8.7	83	8.4	19.0	19
Oct	1.8	147	0.0	8.9	82	9.6	13.0	20
Nov	1.8	106	0.0	5.8	63	11	6.8	4
Min.		80	0.0	4.2	42	7.5	0.0	4
Avg.		120	0.03	6.7	69	10.0	11	29
Max.		175	0.3	11.0	94	13.0	21	75
No.		31	31	31	31	31	30	5

Q = Flow, thousand acre-feet/month
EC = Electrical Conductivity, mhos/cm
HCO3 = Bicarbonate, mg/l
DO = Dissolved Oxygen, mg/l
B = Boron, mg/l
Na = Sodium, mg/l
TRB = Turb. Units
T = Temp., degrees C
(Data from Water Quality Control Plan, Basin 5A)

Alturas Basin ground water is sodium bicarbonate in character,

and generally of good mineral quality. The data in Table 3 is summarized from the analysis of well water in a recent ground water study [13]:

Table 3. Alturas Basin Ground Water Quality

Constituent	Wells	Range	Median
TDS (mg/l)	141	100 - 1600	260
EC (mhos/cm @ 25 degrees C)	141	76 - 2400	315
Chlorides (mg/l)	70	0 - 271	8
Sulfates (mg/l)	90	0 - 626	16
Alkalinity as CaCO3 (mg/l)	--	37 - 487	--
pH	--	7 - 8.5	--
ASAR	118	0 - 23	2.3
Boron (mg/l)	--	0 - 4.6	0.03
Nitrate (mg/l)	16	0 - 38	4.2

6. Water Quality Impacts

There are some localized water quality problems in the Alturas Basin. The ground water which is limiting to beneficial uses is drawn from confined portions of the Alturas Formation, and/or from ground water migrating along geologic faults. The highest conductivity is associated with the lake deposits of the Alturas Formation, and with the structural systems that formed the basin.

The permanent ponds of the Modoc refuge freeze in late November. The refuge manager has observed fish kills after the spring thaw, and thinks that this is most likely due to an oxygen depletion problem in the ponds [13].

The South Fork of the Pit River and the Pit River are spawning grounds for resident fish, including rainbow and brook trout. A large fish kill is alleged to have occurred in the South Fork near the pellet plant on Beet Camp Road in July 1985. The cause of the kill is unknown, but chemicals associated with agricultural use are suspected [14].

B. Ash Creek Wildlife Management Area

The Ash Creek Wildlife Management Area was acquired by the California Department of Fish and Game (DFG) in 1986. The purpose of the wildlife area is to preserve wildlife habitat. The marsh area of the refuge is a waterfowl breeding ground. Ash Creek is a spawning area for resident inland fish, including the

fully protected Modoc sucker. The 11,525 acre management area, which was formerly a cattle ranch, is located in Big Valley, Modoc and Lassen Counties, between the towns of Adin and Bieber (Figure 2).

1. Water Supply and Land Use

Ash Creek and Willow Creek flow into the wildlife area and sustain a seasonal marsh and the western side of the area.

Cattle grazing is the primary agricultural land use surrounding the area, but alfalfa, grass hay, and grains are also grown (Table 4). Quail Valley Ranch produces irrigated alfalfa along the western and northern boundaries of the wildlife area.

2. Potential Impacts

DFG staff expressed concern towards potential agricultural drainage impacts on this new refuge. Agrichemical use in the area includes sport applications of picloram (tordon) for scotch thistle control. Strychnine and 1080 have been used for rodent control, but none was used in 1987. Herbicides are applied to hay fields for weed control, but there is limited crop production upstream of the refuge, and limited use of chemicals.

IV. STUDY APPROACH AND RATIONALE

The study was constrained by staff time and analytical funds. Accordingly, analytical tests covered only those pesticides that were known to have been used in the study areas or that were likely to have been used in the past. Selected heavy metals and trace metals were included in the analyses because of their propensity to be toxic to fish and wildlife at relatively low levels and because some agricultural chemicals contain metals.

There appeared to be two general approaches for monitoring. One approach would be to sample specific waters upstream, within, and downstream of specific fields during and immediately after application of chemicals. The second approach would be to sample water stations at key locations throughout the study area after fall and spring chemical use, but not as dictated by use on specific fields. The second approach was chosen. It appeared adequate to achieve the study objective, and appeared to be the more cost-effective of the two approaches. It gave an overall idea of whether chemicals were lingering in the surface water environment and whether additional investigatory work appears justified in the study areas.

Only the water media was analyzed for pesticides, metals and trace elements. The chemicals known to have been used since the

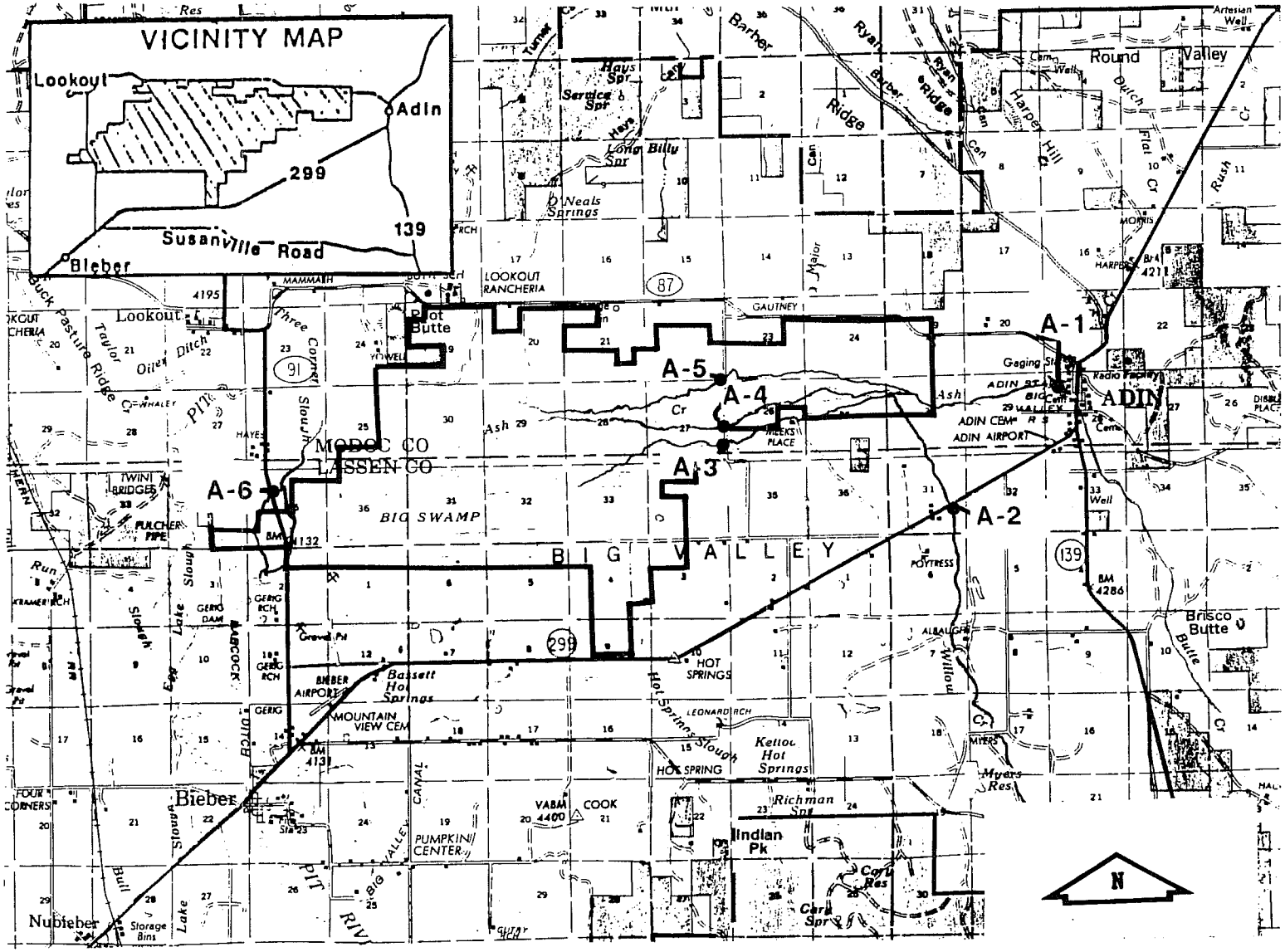


Figure 2. Ash Creek Wildlife Area: Inflow streams and sampling stations.

TABLE 4. CROP PRODUCTION AND CHEMICAL USE IN MODOC COUNTY WATERSHED UPSTREAM FROM ASH CREEK WILDLIFE AREA, 1987

Crop	Acreage	Known Pesticides Used Since 1980	Season of Use
Alfalfa	1,250	2,4-D	Spring
		Simazine	Spring/Fall
		Velpar	Fall
		Sencor	Spring
		Furadan	Spring
		Picloram	Summer
Meadow Hay	900	Velpar	Spring
		Picloram	Summer
Grain Hay	1,100	2,4-D	Spring
		Picloram	Summer
Irrigated Pasture	3,200	Velpar	Spring
		Simazine	Spring/Fall
		Picloram	Summer
Wheat	150	2,4-D	Spring
		Dicamba	Spring
Barley	300	2,4-D	Spring
		Dicamba	Spring
Oats	350	2,4-D	Spring
		Dicamba	Spring
Rye	100	?	?
Field Crops	460	?	?

early 1980s are not cumulative in wildlife tissue and do not persist for long periods after application. The assumption was that if toxicants were measured in water entering and present in the refuge, a potential problem was extant. If toxicants were undetectable in the water supply, then toxic substances would not be expected in organism tissues or in the aquatic substrate and would be an unlikely source of wildlife problems.

Although magnacide was used for weed control in canals south of the Modoc Refuge, it was not sampled because canal water is not discharged to other surface waters until the chemical has deteriorated. Also, 1080 was not included in analyses because the chemical is incorporated in bait that is applied to land.

V. RESULTS

A. Modoc National Wildlife Refuge

Refuge and inflow samples were taken at 11 stations during January and June of 1987. This was after the fall and spring peak use of pesticides. Amounts of applied chemicals are not known, but in the opinion of the Modoc County Agriculture Commissioner's office staff, less than historic amounts were applied in 1987.

Analytical results are shown in Table 5 and Appendix 1. None of the analyzed pesticides exceeded the level of detectability. Metal and trace element concentrations were similar to normal background levels in the Pit River system.

B. Ash Creek Wildlife Area

Refuge, inflow, and outflow samples were taken at six stations during January and June of 1987 after the peak periods of pesticide use. Amounts of applied chemicals are not known, but the owner of the feed store in McArthur (a pesticide supplier) felt that less chemicals than usual were used in the area during 1987.

Analytical results are presented in Table 6 and Appendix 1. None of the analyzed chemicals exceeded the level of detectablility. Metal and trace element concentrations were similar to normal background levels in the Pit River system.

VI. CONCLUSIONS

Based on the limited sampling and appraisal done in 1987, present agricultural drainage does not pose a threat to wildlife and

TABLE 5. RESULTS OF MODOC NATIONAL WILDLIFE REFUGE SAMPLING[1]

Station	Location	Sampled	OC[2] Pesticides	OP Pesticides	2,4-D[3]	Simazine	Dicamba	Eptam	Furadan	Picloram	As	Cd	Cu	Pb	Hg	Mb	Ni	Se	Th	Zn
M-1	S. Fk. Pit	01/06/87	<0.1	<0.1	<1	<1	<1	<1	<1	<1	<2.5	<0.2	2	<5	<0.2	<5	<5	<1	<10	<5
	near Likely	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	5	-	-	-	-	-	-	-
M-2	Westside	01/06/87	-	-	<1	<1	<1	<1	<1	<1	<2.5	<0.2	4	<5	<0.2	<5	<5	<1	<10	<5
	Canal	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	4	-	-	-	-	-	-	-
M-3	S. Fk. Pit	01/06/87	-	-	<1	<1	<1	<1	<1	<1	<2.5	<0.2	3	<5	<0.2	<5	<5	<1	<10	<5
	@ Jones Ln.	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	3	-	-	-	-	-	-	-
M-4	Eastside	01/06/87	-	-	<1	<1	<1	<1	<1	<1	<2.5	<0.2	3	<5	<0.2	<5	<5	<1	<10	<5
	Canal	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	3	-	-	-	-	-	-	-
M-5	S. Fk. Pit	01/06/87	<0.1	-	<1	<1	<1	<1	<1	<1	<2.5	<0.2	3	<5	<0.2	<5	<5	<1	<10	<5
	@ 395 Br.	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	<2	-	-	-	-	-	-	-
M-6	Pine Creek	01/06/87	-	-	<1	<1	-	-	-	<1	<2.5	<0.2	<2	<5	0.2	<5	<5	<1	<10	<5
	near mouth	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	-	-	-	-	-	-	-	-
M-7	Spring NE	01/06/87	-	-	<1	<1	<1	<1	<1	<1	4.7	<0.2	3	<5	0.2	5	<5	<1	<10	<5
	Refuge Hdq.	06/24/87	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M-8	Dorris Res.	01/06/87	-	-	<1	<1	-	-	-	<1	<2.5	<0.2	10	<5	0.2	<5	7	<1	<10	17
	Outflow	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	-	-	-	-	-	-	-	-
M-9	N. Fk. Pit	01/06/87	-	-	<1	<1	-	-	-	<1	<2.5	<0.2	3	<5	<0.2	<5	<5	<1	<10	<5
	@ S. Fork	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	-	-	-	-	-	-	-	-
M-10	Pit R.	01/06/87	<0.1	<0.1	<1	<1	<1	<1	<1	<1	<2.5	<0.2	2	<5	0.2	<5	<5	<1	<10	<5
	@ WWTP	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	<2	-	-	-	-	-	-	-
M-11	Parker Ck.	01/06/87	-	-	<1	<1	-	-	-	<1	<2.5	<0.2	<2	<5	<0.2	<5	<5	<1	<10	<5
	near mouth	06/24/87	-	-	<1	-	<1	-	-	<1	-	-	-	-	-	-	-	-	-	-

1= Micrograms per liter (ug/l)
OC = Organochlorine
2 = Toxaphene<1 ug/l
OP = Organophosphate
3 = See Appendix 1

TABLE 6. RESULTS[1] OF ASH CREEK WILDLIFE AREA SAMPLING

ation	Location	Sampled	Organochlorine Pesticides[2]	Organophosphate Pesticides	2,4-D	Simazine	Dicamba	Furadan	Picloram	Velpar	Sencor	As	Cd	Cu	Pb	Hg	Mb	Ni	Se	Th	Zn
A-1	Ash Cr. @	1/15/87	0.1	0.1	<1	<1	<1	<1	<1	<1	<1	<2.5	<0.2	<2	<5	<0.2	<5	<5	<1	<10	<5
	Adin	6/25/87			<1	-	<1	-	<1	-	-	-	-	4	-	-	-	-	-	-	-
A-2	Willow Cr.	1/15/87	-	-	<1	<1	<1	<1	<1	<1	<1	<2.5	<0.2	2	<5	<0.2	<5	<5	<1	<10	<5
	@ Hyway 299	6/25/87	-	-	<1	-	<1	-	<1	-	-	-	-	<2	-	-	-	-	-	-	-
A-3	Ash Cr. S.	1/15/87	-	-	<1	<1	<1	<1	<1	<1	<1	<2.5	<0.2	6	<5	<0.2	<5	<5	<1	<10	<5
	Channel,Rd. No. A21	6/25/87	-	-	<1	-	<1	-	<1	-	-	-	-	4	-	-	-	-	-	-	-
A-4	Ash Cr. Mid	1/15/87	-	-	<1	<1	<1	<1	<1	<1	<1	<2.5	<0.2	4	<5	<0.2	<5	<5	<1	<10	<5
	Channel, Rd No. A21	6/25/87	-	-	<1	-	<1	-	<1	-	-	-	-	<2	-	-	-	-	-	-	-
A-5	Ash Cr. N.	1/15/87	-	-	<1	<1	<1	<1	<1	<1	<1	<2.5	<0.2	3	<5	<0.2	<5	<5	<1	<10	<5
	Channel,Rd. No. A21	6/25/87	-	-	<1	-	<1	-	<1	-	-	-	-	4	-	-	-	-	-	-	-
A-6	Ash Cr. @	1/15/87	0.1	0.1	<1	<1	<1	<1	<1	<1	<1	<2.5	<0.2	3	<5	<0.2	<5	<5	<1	<10	5
	Hyway 91	6/25/87	-	-	<1	-	<1	-	<1	-	-	-	-	<2	-	-	-	-	-	-	-

[1] = Micrograms per liter (ug/l) [2] = Toxaphene 1, See Appendix 2

aquatic life in either the Modoc National Wildlife Refuge or Ash Creek Wildlife Area. Pesticides used in the area, either in 1987 or in the past, were undetectable in the water environment. Other toxics, i.e., metals, were at normal background levels in refuge waters and inflow waters. Presently used chemicals are not known to accumulate in the tissue of organisms. Accordingly, there is no reason to suspect bioaccumulation of toxics.

Unless chemical types, intensity of use, or methods of use change, there appears to be no need for routine monitoring of toxics in waters supplying the two areas.

VII. REFERENCES

1. U.S. Bureau of Reclamation. 1986. Central Valley Fish and Wildlife Management Study. Draft Report: Refuge Water Supply Investigation Problem B-1, Part II. Sacramento Valley Wildlife Refuges.

2. U.S. Fish and Wildlife Service. 1986. Preliminary Survey of Contaminant Issues of Concern on National Wildlife Refuges. Division of Refuge Management.

3. University of California Cooperative Extension Service, Modoc County. 1982. Modoc County: Wildlife, Economics, Climate, Agricultuire, Geography.

4. Central Valley Regional Water Quality Control Board. 1962. Pit River Water Quality Investigation. Staff Report.

5. Central Valley Regional Water Quality Control Board. 1975. Water Quality Control Plan, Central Valley Region, Basin 5A.

6. California Department of Water Resources. 1983. Water Quality Investigation: Pit River. Northern District Report.

7. California Department of Water Resources. 1964. Upper Pit River Investigation. Bulletin 86.

8. California Division of Mines and Geology. 1980. Geologic Data Map No. 4: Geothermal Resouorces of California.

9. California Division of Mines and Geology. 1968. Geologic Map Series: Alturas Sheet.

10. Modoc County Department of Agriculture. 1985. 1985 Crop Report (Preliminary).

11. Zander, G. 1933. South Fork of Pit River Court Reference Report on Water Supply and Use of Water on South Fork of Pit River and Tributaries, Modoc and Lassen Counties, California. State of California Department of Public Works, Division of Water Resources.

12. California Department of Food and Agriculture. 1978. Report on Environmental Assessment of Pesticide Programs: Modoc County Component.

13. California Department of Water Resources. 1986. Alturas Ground water Basin Water Quality Study. Northern District report.

14. Bloom, Clark. 1987. Manager, Modoc National Wildlife Refuge. Personal communication.

APPENDIX 1

WATER QUALITY ANALYTICAL RESULTS

Engineers
Planners
CH2M HILL Economists
Scientists

February 27, 1987

R299.35

WATER QUALITY CONTROL BOARD
100 E. Cypress Ave.
Redding, CA 96002

Attention: Bob Lewis

Dear Bob:

Please find enclosed the results of organics tested on your samples labelled M-1 thru M-11; our lab reference #16281. You will find that we did not report a result for 2,4-D on the report.

The samples for 2,4-D analysis were improperly spiked. Instead of spiking with 2,4-DP, the samples were spiked with 2,4-D at a concentration of 1 ug/l. Since we were sample limited we could not re-extract a fresh sample. The results of the samples are given below:

Sample	2,4,-D (ug/l)
M-1	0.85
M-2	0.56
M-3	0.53
M-4	0.50
M-5	0.48
M-6	0.61
M-7	0.66
M-8	0.56
M-9	0.56
M-11	0.69
Mean:	0.60
Standard deviation:	0.11

For a 95% confidence interval the mean is described by $\bar{x} \pm t$ times (standard deviation $\div \sqrt{n}$). For a normal distribution $t = 2.26$ for $n = 10$. Therefore, the mean of 0.60 is good to ± 0.08 indicating a precision of about 13% relative standard deviation. The mean percent recovery of a 1 ug/l spike was 60%. From this data a good presumption is that the concentration of the 2,4-D in these samples are below 1 ug/l which is our common reporting limit, but without being able to analyze the sample it cannot be confirmed.

CH2M HILL, INC. Redding Office 1525 Court Street; P.O. Box 2088, Redding, California 96099 916.243.5831

The reason M-10 was not included in this set of results is that this sample bottle broke and there was not enough to re-extract. This sample was analyzed with the correct surrogate spike.

Please accept my apology for our mistake. In the future we should collect more sample volume to ensure an opportunity to retest.

If you have any questions please call me.

Sincerely,

James E. Hawley
Department Manager

JEH/bh
Encl.

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WQCB
100 E. CYPRESS AVE.
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-MODOC WILDLIFE REFUGE
DATE OF SAMPLE: SEE BELOW

REFERENCE NUMBER: 16281

DATE: 2/23/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/8/87

TEST METHODS: EPA-608-8090

SAMPLE RESULT *(PPB)

CONSTITUENT	M-1 1/6/87	M-5 1/7/87	M-10 1/7/87
Aldrin	<0.1	<0.1	<0.1
a-BHC	<0.1	<0.1	<0.1
b-BHC	<0.1	<0.1	<0.1
d-BHC	<0.1	<0.1	<0.1
g-BHC	<0.1	<0.1	<0.1
Chlordane	<0.1	<0.1	<0.1
4,4-DDD	<0.1	<0.1	<0.1
4,4-DDE	<0.1	<0.1	<0.1
4,4-DDT	<0.1	<0.1	<0.1
Dieldrin	<0.1	<0.1	<0.1
Endosulfan I	<0.1	<0.1	<0.1
Endosulfan II	<0.1	<0.1	<0.1
Endosulfan Sulfate	<0.1	<0.1	<0.1
Endrin	<0.1	<0.1	<0.1
Endrin Aldehyde	<0.1	<0.1	<0.1
Heptachlor	<0.1	<0.1	<0.1
Heptachlor Epoxide	<0.1	<0.1	<0.1
Methoxychlor	<0.1	<0.1	<0.1
Toxaphene	<1	<1	<1

*PPB: ug/l water or ug/kg soil
COMMENTS: See attached letter for 2,4-D results.

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

ANALYST: Brian Goss APPROVED BY:

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WQCB
100 E. CYPRESS AVE.
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-MODOC WILDLIFE REFUGE
DATE OF SAMPLE: 1/6 & 1/7/87

REFERENCE NUMBER: 16281

DATE: 2/23/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/8/87

TEST SAMPLE	SIMAZINE	DICAMBA	EPTAM	FURADAM	PICLORAM
M-1	<1	<1	<1	<1	<1
M-2	<1	<1	<1	<1	<1
M-3	<1	<1	<1	<1	<1
M-4	<1	<1	<1	<1	<1
M-5	<1	<1	<1	<1	<1
M-6	<1	--	--	--	<1
M-7	<1	<1	<1	<1	<1
M-8	<1	--	--	--	<1
M-9	<1	--	--	--	<1
M-10	<1	<1	<1	<1	<1
M-11	<1	--	--	--	<1

COMMENTS: Results in micrograms per liter

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

APPROVED BY: J. C. Hawley

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WQCB
100 E. CYPRESS AVE.
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-MODOC WILDLIFE REFUGE
DATE OF SAMPLE: SEE BELOW

REFERENCE NUMBER: 1628

DATE: 2/23/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/8/87

ORGANOPHOSPHATE	M-1 1/6/87	M-10 1/7/87
Azinphos methyl	<0.1	<0.1
Demeton	<0.1	<0.1
Diazinon	<0.1	<0.1
Disulfoton	<0.1	<0.1
Ethion	<0.1	<0.1
Malathion	<0.1	<0.1
Parathion ethyl	<0.1	<0.1
Parathion methyl	<0.1	<0.1

COMMENTS: Results in micrograms per liter

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

APPROVED BY: J. Stanley

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WQCB
100 E. CYPRESS AVE.
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-MODOC WILDLIFE REFUGE
DATE OF SAMPLE: SEE BELOW

REFERENCE NUMBER: 16281
PAGE 4 OF 5
DATE: 2/23/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/8/87

TEST	M-1 1/6/87	M-2 1/6/87	M-3 1/6/87	M-4 1/6/87	M-5 1/7/87	M-6 1/6/87
Arsenic	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Cadmium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Copper	<0.002	0.004	0.003	0.003	0.003	<0.002
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002
Molybdenum	<0.005	0.005	<0.005	<0.005	<0.005	<0.005
Nickel	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

COMMENTS: Results in milligrams per liter

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

APPROVED BY J. Hawley

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WQCB
100 E. CYPRESS AVE.
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-MODOC WILDLIFE REFUGE
DATE OF SAMPLE: 1/7/87

REFERENCE NUMBER: 16281
PAGE 5 OF 5
DATE: 2/23/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/8/87

TEST	M-7	M-8	M-9	M-10	M-11
Arsenic	0.0047	<0.0025	<0.0025	<0.0025	<0.0025
Cadmium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Copper	0.003	0.010	0.003	0.002	<0.002
Lead	<0.005	<0.005	<0.005	<0.005	<0.005
Mercury	0.0002	0.0002	<0.0002	0.0002	<0.0002
Molybdenum	0.005	<0.005	<0.005	<0.005	<0.005
Nickel	<0.005	0.007	<0.005	<0.005	<0.005
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	<0.005	0.017	<0.005	<0.005	<0.005

COMMENTS: Results in milligrams per liter

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

APPROVED BY: J. R. Hawley

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WATER QUALITY CONTROL BOARD
100 E. CYPRESS AVENUE
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-ASH CR. WILDLIFE AREA
DATE OF SAMPLE: 1/15/87

REFERENCE NUMBER: 16332
PAGE 1 OF 4
DATE: 2/25/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/16/87

TEST METHODS: EPA-608-8090

SAMPLE RESULT *(PPB)

CONSTITUENT	A-1	A-6
Aldrin	<0.1	<0.1
a-BHC	<0.1	<0.1
b-BHC	<0.1	<0.1
d-BHC	<0.1	<0.1
g-BHC	<0.1	<0.1
Chlordane	<0.1	<0.1
4,4-DDD	<0.1	<0.1
4,4-DDE	<0.1	<0.1
4,4-DDT	<0.1	<0.1
Dieldrin	<0.1	<0.1
Endosulfan I	<0.1	<0.1
Endosulfan II	<0.1	<0.1
Endosulfan Sulfate	<0.1	<0.1
Endrin	<0.1	<0.1
Endrin Aldehyde	<0.1	<0.1
Heptachlor	<0.1	<0.1
Heptachlor Epoxide	<0.1	<0.1
Methoxychlor	<0.1	<0.1
Toxaphene	<1	<1

*PPB: ug/l water or ug/kg soil

COMMENTS:

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

ANALYST: Brian Glen APPROVED BY: Brian Glen

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WATER QUALITY CONTROL BOARD
100 E. CYPRESS AVENUE
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-ASH CR. WILDLIFE AREA
DATE OF SAMPLE: 1/15/87

REFERENCE NUMBER: 16332
PAGE 2 OF 4
DATE: 2/25/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/16/87

TEST	A-1	A-2	A-3	A-4	A-5	A-6
Furadan	<1	<1	<1	<1	<1	<1
Picloram	<1	<1	<1	<1	<1	<1
Simazine	<1	<1	<1	<1	<1	<1
Velpar	<1	<1	<1	<1	<1	<1
Sencor	<1	<1	<1	<1	<1	<1
2,4-D	<1	<1	<1	<1	<1	<1
Dicamba	<1	<1	<1	<1	<1	<1

COMMENTS: mg/l = milligrams per liter

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

APPROVED BY: Brian Jones

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WATER QUALITY CONTROL BOARD
100 E. CYPRESS AVENUE
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-ASH CR. WILDLIFE AREA
DATE OF SAMPLE: 1/15/87

REFERENCE NUMBER: 16332

DATE: 2/25/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/16/87

TEST	A-1	A-6
Organophosphate Scan	<0.1	<0.1
Azinphos methyl	<0.1	<0.1
Demeton	<0.1	<0.1
Diazinon	<0.1	<0.1
Disulfoton	<0.1	<0.1
Ethion	<0.1	<0.1
Malathion	<0.1	<0.1
Parathion ethyl	<0.1	<0.1
Parathion methyl	<0.1	<0.1

COMMENTS: ug/l = micrograms per liter

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

APPROVED BY: Brian Ellers

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WATER QUALITY CONTROL BOARD
100 E. CYPRESS AVENUE
REDDING, CA 96002
ATTENTION: BOB LEWIS
SAMPLE DESCRIPTION: WATER-ASH CR. WILDLIFE AREA
DATE OF SAMPLE: 1/15/87

REFERENCE NUMBER: 16332
PAGE 4 OF 4
DATE: 2/25/87
PHONE: 225-2045
SAMPLED BY: CLIENT
DATE RECEIVED: 1/16/87

TEST	A-1	A-2	A-3	A-4	A-5	A-6
Arsenic	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Cadmium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Copper	<0.002	0.002	0.006	0.004	0.003	0.003
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nickel	<0.005	<0.005	<0.005	0.005	<0.005	<0.005
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	<0.005	<0.005	<0.005	<0.005	<0.005	0.005

COMMENTS: Results in milligrams per liter

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

APPROVED BY: Brian Goss

CH2M HILL ENVIRONMENTAL LABORATORY
2218 RAILROAD AVENUE
REDDING, CA 96001 916-243-5831

REPORT TO: WATER QUALITY CONTROL BOARD
100 E. CYPRESS AVENUE
REDDING, CA 96002
ATTENTION: R.H. LEWIS
SAMPLE DESCRIPTION: WATER
DATE OF SAMPLE: SEE REPORT

REFERENCE NUMBER: 17608
PAGE 1 OF 1
DATE: 8-18-87
PHONE: 225-2045
SAMPLED BY: R.H. LEWIS
DATE RECEIVED: 6-25-87

TEST		COPPER
UNITS		ug/l
SAMPLES		
M-1	6-24-87	5
M-2	6-24-87	4
M-3	6-24-87	3
M-4	6-24-87	3
M-5	6-24-87	<2
M10	6-24-87	<2
A-1	6-25-87	4
A-2	6-25-87	<2
A-3	6-25-87	4
A-4	6-25-87	<2
A-5	6-25-87	4
A-6	6-25-87	<2

COMMENTS: Results are in micrograms per liter

The information shown on this sheet is test data only and no analysis or interpretation is intended or implied.

APPROVED BY: _____

NORTH COAST LABORATORIES LTD.

5680 WEST END ROAD • ARCATA • CA 95521 • (707) 822-4649

Date: 10 August 1987

Report to: CH2M Hill
2218 Railroad Avenue
Redding, CA 96001
Attn: Barb Hurley

Date Received: 06-29-87 Date Sampled: Unknown

CHEMICAL EXAMINATION REPORT

SAMPLE DESCRIPTION	Client I.D.	NCL #	PARAMETER	RESULTS
17608-1	M-1	35736	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-2	M-2	35739	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-3	M-3	35742	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-4	M-4	35745	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-5	M-5	35748	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-6	M-10	35751	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-7	M-6	35754	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-8	A-1	35757	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L

Comments:

Project Chemist: BL

QA Check: [signature]

Jesse G. Chaney, Jr.
Laboratory Director

Typed By: vav

NORTH COAST LABORATORIES LTD.

5680 WEST END ROAD • ARCATA • CA 95521 • (707) 822-4649

Date: 07 August 1987

Report to: CH2M Hill
2218 Railroad Avenue
Redding, CA 96001
Attn: Barb Hurley

Date Received: 06-29-87 Date Sampled: Unknown

CHEMICAL EXAMINATION REPORT

SAMPLE DESCRIPTION	CLIENT I.D.	NCL #	PARAMETER	RESULTS
17608-9	A-2	35760	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-10	A-3	35763	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-11	A-4	35766	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-12	A-5	35769	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-13	A-6	35772	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-14	M-8	35775	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-15	M-9	35778	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L
17608-16	M-11	35781	Tordon	<1 ug/L
			Dicamba	<1 ug/L
			2,4 - D	<1 ug/L

Comments:

Project Chemist: BL

QA Check: _____

Jesse G. Chaney, Jr.
Laboratory Director

Typed By:vav